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FLEXIBLE ROLLED-UP SOLAR ARRAY

SEVENTH QUARTERLY REPORT

APRIL 1970

AFAPL/P-2

PROJECT NO. 682J/DATA NO. HS207-205(7)/CONTRACT NO. F33615-68-C-1676

PREPARED BY:
Hughes Aircraft Company / Space Systems Division
(Under Contract F33615-68-C-1676)

AUTHORS: E. O. Felkel
G. Wolff
Et al.

Hughes Ref. No. 70(22)-3823/B3532-010

SSD 00189R

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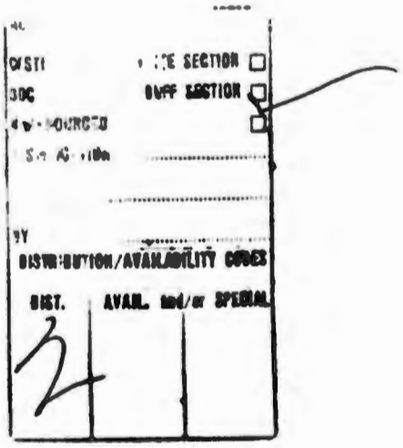

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PREPARED FOR:
Air Force Aero Propulsion Laboratory
Research and Technology Division
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FOREWORD

This report was prepared by Hughes Aircraft Company, Space Systems Division, El Segundo, California, under Contract F33615-68-C-1676. The work was administered under the direction of L. D. Massie, APIP-2, Air Force Aero Propulsion Laboratory.

The period covered extends from 22 December 1969 to 29 March 1970. Contributors to this report include E. O. Felkel, G. Wolff, M. C. Olson, W. N. Turner, R. E. Daniel, G. P. Steffen, D. Plummer, R. K. Geiser, D. Garth, C. Duncan, and D. Lane, all of Hughes Aircraft Company, Space Systems Division, El Segundo, California.

The work covered herein was accomplished under Air Force Contract F33615-68-C-1676, but this report is being published and distributed prior to Air Force review. Publication of this quarterly, therefore, does not constitute approval by the Air Force of the findings or conclusions contained herein. It is published for the exchange and stimulation of ideas.

ABSTRACT

The main activities on the Flexible Rolled-Up Solar Array (FRUSA) program during the seventh quarterly reporting period consisted of drawing release of all the FRUSA subsystem components, with the exception of the power electronics and storage, and startup of manufacturing of the development/qualification model. The solar cells required for the qualification model have been received and wired into the required cell groups ready for bonding, together with the blanks, to the solar panel. The storage drum is in the final stage of fabrication, and the small and large housings for the orientation mechanism are ready for final processing prior to start of assembly.

The design of the reaction wheel drive and a verification test of the critical circuits of the drive, which provide an analog of wheel rate from pulse-type rate pickoff data, have been successfully completed. A complete power subsystem breadboard test program was started during the reporting period. The changes requested by the customer to make the FRUSA telemetry system compatible with the Agena PCM system, to increase the deployment arm length and decrease the orientation mechanism slew rate, have been implemented in the design.

The Performance, Design and Product Confirmation Requirements Specification (DS 30992-001) reflecting all necessary modification as of 15 March 1970 has been released. The FRUSA Interface Requirements document has been upgraded and a revision of the Quality Plan published.

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ILLUSTRATIONS

TABLES

SECTION I

INTRODUCTION AND SUMMARY

This document reports progress in the seventh quarter (22 December 1969 to 29 March 1970) on AFAPL contract F33615-68-C-1676, Flexible Rolled-Up Solar Array, Project Number 682J.

The main activities on the Flexible Rolled-Up Solar Array (FRUSA) program during the seventh quarterly reporting period consisted of drawing release of all the FRUSA subsystem components, with the exception of the power electronics and storage, and startup of manufacturing of the development/qualification model. The solar cells required for the qualification model have been received and wired into the required cell groups ready for bonding, together with the blanks, to the solar panel. The storage drum is in the final stage of fabrication and the small and large housings for the orientation mechanism are ready for final processing prior to start of assembly.

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The Performance, Design and Product Confirmation Requirements Specification (DS 30992-001) reflecting all necessary modification as of 15 March 1970 has been released. The FRUSA Interface Requirements document has been upgraded and a revision of the Quality Plan published.

The format of this report is designed to present the status of each major system element in a separate section.

SECTION II

PROGRAM STATUS

The Flexible Rolled-Up Solar Array (FRUSA) program is divided into five phases, as described in the paragraphs that follow. The current program schedule and status are shown in Figure 1.

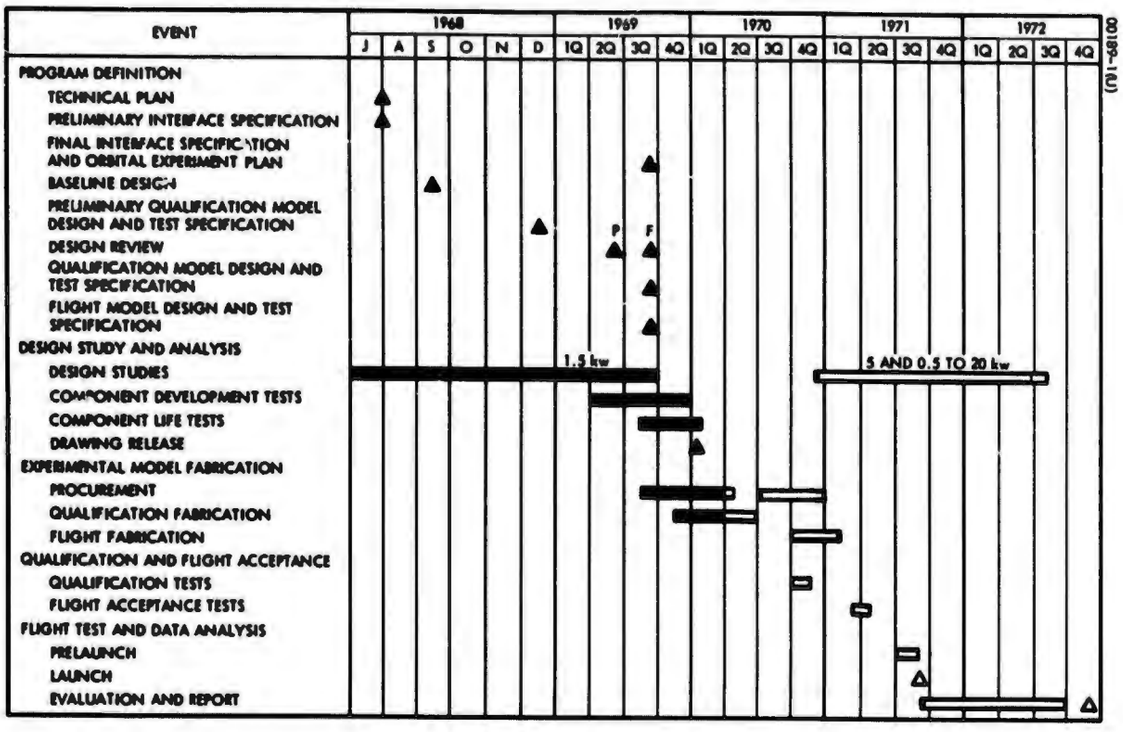


Figure 1. Program Schedule

PHASE I – PROGRAM DEFINITION

Major milestones associated with this phase and scheduled during this period have been completed. Included in this category are all the program requirements, design, and test requirements.

PHASE II – DESIGN STUDY AND ANALYSIS

The study phase of the program has been completed and a firm baseline design established. Design packaging details are continuing. The formal test plan has been established and is in process of being released. All ICDs – unit, subsystem and system level – have been released.

PHASE III – MODEL FABRICATION

Engineering drawing release except for the power electronics and storage subsystem has been accomplished. Fabrication of the engineering/qualification model is proceeding on schedule. About 70 percent of the piece parts have been received with the balance due by 30 April 1970. Assembly operations on the panel and orientation mechanism have been started.

PHASE IV – QUALIFICATION AND FLIGHT ACCEPTANCE TESTS

Qualification and flight acceptance tests will be conducted according to the test plan.

PHASE V – FLIGHT TEST AND DATA ANALYSIS

The flight test and data analysis phase will include prelaunch checkout and countdown procedures as well as in-orbit operation and analysis.

SECTION III

SYSTEM ENGINEERING

DOCUMENTATION

The Performance, Design and Product Confirmation Requirements Specification (DS 30992-001) has been released and copies are being distributed. This revision of the preliminary specification is the initial formal release and reflects all necessary modification as of 15 March 1970.

The FRUSA interface requirements document was upgraded to include the following requirements:

1) Compatibility of the FRUSA PAM commutators with the PCM commutators of the spacecraft

2) Addition of two commands required for separate battery charge controller on/off switching

3) Deletion of the FRUSA flight plug and the requirement that this switching be accomplished by a spacecraft relay

An update of the preliminary cable interconnection drawing is in process. This update will ensure standardization of nomenclature and pin to pin compatibility of all connectors. This effort will be completed during this report period.

REGULATOR RESPONSE

Unit engineers experienced a problem with the transient response of the 28 volt regulator. The Hughes initial specification called for a maximum of 1 volt for 1 ms under a load change from 10 to 100 percent. A considerable amount of additional filtering over that presently planned would be required to meet this specification. An analysis of the power load histogram was completed and indicated these values were unnecessarily tight. The new revision of the specification reflects a requirement that the transient response must not exceed 1 volt for 1 ms under a load change from 50 to 100 percent.

FRUSA WEIGHT SUMMARY

A current system weights by individual unit is shown in Table I. The new format for reporting weights has been adopted to reflect the subsystem and unit nomenclature.

TABLE I. FRUSA FLIGHT WEIGHT SUMMARY

Item		Weight, pounds
Solar Array Subsystem		70.6
Drum mechanisms	34.3	
Array panels	36.3	
Orientation Mechanism Subsystem		49.1
Orientation mechanism	41.9	
Control electronics unit	7.2	
Power Conditioning and Storage Subsystem		55.5
Battery/charge controllers	42.0	
Power conditioning unit	13.5	
Instrumentation Subsystem		17.1
Accelerometers	5.0	
Solar cell electronics	4.7	
Strain gage amplifiers	0.8	
Instrumentation conditioning unit	1.0	
Commutators	3.3	
Current sensors, harness, etc.	2.3	
Flexible Rolled-Up Solar Array System		192.3
Resistive load bank		35.0
Contingency		22.7
Total Flight System Weight		250.0

PLANS FOR NEXT QUARTER

1) Publish upgraded technical plan

2) Upgrade and modify interface requirements document

3) Release FRUSA system harness schematic

SECTION IV

SOLAR ARRAY SUBSYSTEM

SUBSYSTEM DESCRIPTION AND STATUS

The solar array subsystem consists of two flexible solar cell arrays that are stored, deployed and retracted by the drum mechanism. The following significant items and tasks were accomplished during the seventh quarter of the program:

1) Completion and release of all detail and assembly drawings for the qualification and flight models of solar panels and drum mechanism

2) Continuation of parts fabrication for qualification model of drum mechanism

3) Start of fabrication for solar panels

4) Completion of assembly procedures for qualification model of solar panels and drum mechanism

5) Completion of cell qualification program

6) Completion of bearing and negator development test program

7) Delivery of engineering/qualification model of boom actuator unit

FABRICATION STATUS

The fabrication of detail parts for the qualification model of the drum mechanism is about 50 percent complete. Assembly has begun on a few of the smaller assemblies for this unit.

All live cell arrays for the qualification model solar panels have been completed and are currently being mechanically and electrically checked. The dummy cell groups as well as some of the etched copper/Kapton bus strips have been fabricated and are ready for assembly to the panel substrate.

A flight quality Kapton cushion has been successfully embossed using some recently developed techniques. The revised procedures have eliminated the tearing and the pattern indexing problems experienced during the initial attempts at full width cushion fabrication.

Two fabrication specifications for the solar arrays have been prepared and released. These specifications define the detail procedures to be

used for fabrication of solar cell groups using the Hughes automatic soldering machine and for assembly of cell groups, dummy cells, bus strips, etc., on the panel substrate.

Another of the fabrication procedures recently completed in preliminary form is the assembly and test requirements for the drum mechanisms and the solar array subsystem.

DESIGN AND ANALYSIS TASK

The detail and assembly drawings for the solar arrays and the drum mechanisms have been completed and released. The assembly and electrical schematic drawings for the complete solar array subsystem (solar arrays and drum mechanism) have also been completed and released.

With the exception of the fixture required for electrical checkout of the solar panels, all tooling design has been completed. This tooling consists of tables and heater blankets for vacuum bonding operations and fixtures for cell and bus strip placement on the panel. The fixture for supporting the solar arrays during electrical tests is currently being designed.

8 MIL CELL QUALIFICATION PROGRAM

The qualification test program on the 8 mil cells with 6 mil coverglasses has been successfully completed at Heliotek. This test program consisted of exposing 100 cells to temperature and humidity tests, thermal shock tests, and high temperature-vacuum tests. The electrical effect of these tests is summarized in Table II.

TABLE II. CELL QUALIFICATION TEST RESULTS

	Average Current at 470 mv, ma	Average Output Power, mw
Initial measurement	114.4	53.77
Post temperature-humidity	113.9	53.53
Post thermal shock	114.7	53.91
Final (post temperature-vacuum) measurement	114.8	53.96
Percent change	0.35	0.35

BEARING AND NEGATOR DEVELOPMENT TESTS

The development test program on the drum bearings, drum negators, and cushion reel negator drive has been completed. The tests completed during this period included the following:

- Drum bearings (current design with titanium shaft sleeves and titanium housing) at room temperature, -150°F, and +230°F
- Drum bearings and simulated flexible flat cable at room temperature, -150°F, and +230°F
- Cushion reel negator drive at room temperature
- Complete system (drum bearings, drum negators, cushion reel drive, and simulated flexible cable) at room temperature, -150°F, and +230°F
- Drum bearings with inner race temperatures 5 to 50°F higher than outer races

The test results indicate adequate margins for all components tested when operating in the expected thermal environment. The more significant results and conclusions are as follows:

- Drum bearing torque levels for essentially uniform temperature distribution (no temperature gradients between inner and outer race) are 0.13, 0.22, and 0.26 in-lb per pair for room temperature, -150°F, and +230°F respectively
- Drum bearing torque for the expected 5° to 10°F differential between inner and outer races is approximately 0.20 in-lb per pair. For ΔT = 30°F, the torque is 0.35 in-lb, still within the allowable levels
- Flexible cable torque levels, based on a simulated cable with representative Kapton/copper, are estimated to be about 2.0 in-lb maximum. This includes two pairs of data cables and two pairs of power cables at -150°F
- Cushion tension, provided by cushion reel negator drive, will be between 0.40 and 1.25 pounds. The larger value corresponds to the empty reel condition where the largest tension is required for proper rollup of the cushion.
- Drum negators, when contoured to compensate for changing drum diameters, will provide total panel tension levels (two panels) between 8 and 12 pounds (see Figure 2). Based on the panel roll-up tests and the allowable boom loads, this range of panel tension is considered acceptable. Complete verification

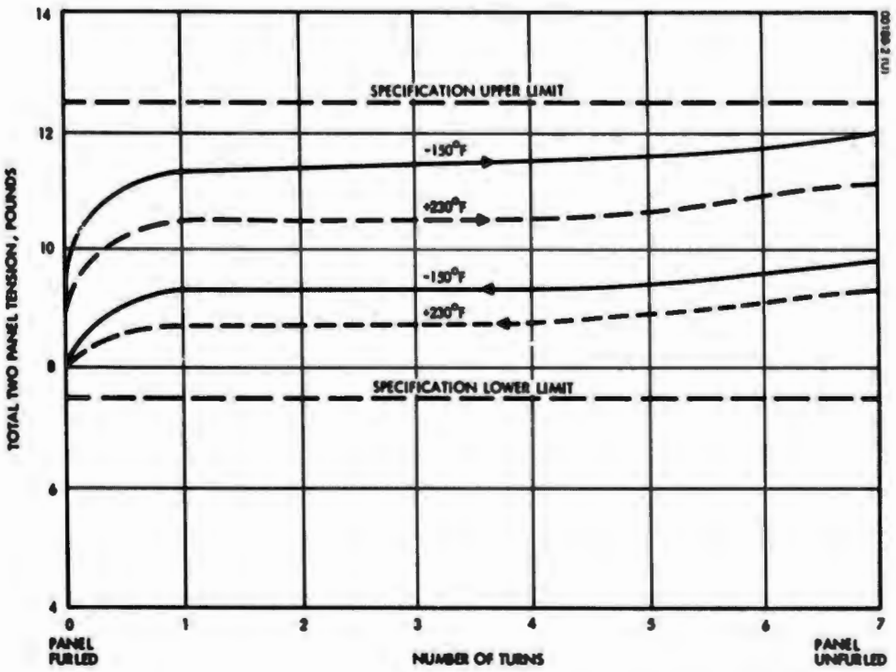


Figure 2. Estimated Average Two-Panel Tension

of acceptability cannot be made, however, until the engineering and qualification tests of the complete subsystem are performed.

PANEL SEGMENT THERMAL SHOCK AND CYCLING TEST

One hundred thermal cycles (+200° to -300° to +200°F in 8 minutes) were recently completed on a representative panel segment with only minor quality control problems. Additional samples are being prepared for more extensive tests. These samples will be subjected to close quality control and inspection procedures to ensure proper fabrication of cell interconnects. In addition, a new photoetched interconnect material will be employed. This material has been used successfully on other Hughes programs and has recently been incorporated in the FRUSA panel design. One of the most significant improvements realized from this material is uniform distribution of solder on the cell contacts. The thermal cycling tests on the new samples will be performed on the thermal-vacuum cycling equipment at Wright-Patterson Air Force Base.

EXTENDIBLE BOOM ACTUATOR UNIT

The engineering/qualification model of the boom actuator unit has been received from SPAR Aerospace. Review of the stress analysis performed on this unit has uncovered some minor structural inadequacies. It appears that, if necessary, relatively easy modifications can be incorporated to correct the problems.

PLANS FOR NEXT QUARTER

1) Continuation of qualification model fabrication and assembly

2) Preparation for engineering tests on drum mechanism and boom actuator unit

3) Start of solar panel thermal shock and cycling retests

4) Preparation of solar array and drum mechanism acceptance test specification

SECTION V

ORIENTATION MECHANISM

SUMMARY

This reporting period saw the completion of the orientation subsystem thermal analysis, leading to specification of the thermal finishes required to maintain unit temperatures well within design limits. No problems were encountered in attaining this end.

Also completed was design of the reaction wheel drive and verification test of the critical circuits of the drive which provide an analog of wheel rate from pulse-type rate pickoff data. Acceptable performance was noted.

Procurement of components and fabrication of parts for the qualification unit are well under way. All deliveries are expected prior to the end of April.

MECHANISM

Sliprings, motors, bearings, and tachometers are progressing satisfactorily at the vendor's, and all units for the qualification model will be delivered in early April. Seventy of a total of 75 parts to be fabricated have been ordered; 40 have been received and are in bonded stores. Assembly of the first unit will begin in April and be completed in May.

SUN SENSORS

Although the FRUSA sun sensor designs were developed and successfully used on the Surveyor program, some sources have questioned the practice of purchasing commercial-grade cadmium-sulfide cells (special cells are not available) and screening them for use in these units. Long-life performance in space was also of interest. Hughes therefore looked into the experience of another facility (JPL) with these cells.

Similar cells and screening processes were used for the JPL Ranger, Mariner 62 and 64, and Venus 67 spacecraft. All cells performed satisfactorily. The Mariner 69 has used and the Mariner 71 will use the same CdS photoconductive material for their sensors, but the cell package is different due to extraordinary vibration level requirements which failed normally packaged cells.

JPL conducted life tests of the CdS cells as a normal requirement for Mariner components. Groups of cells were subjected to various temperature and light conditions for a 9 month period and resistance measurements were made during the course of the test. None of the cells failed to

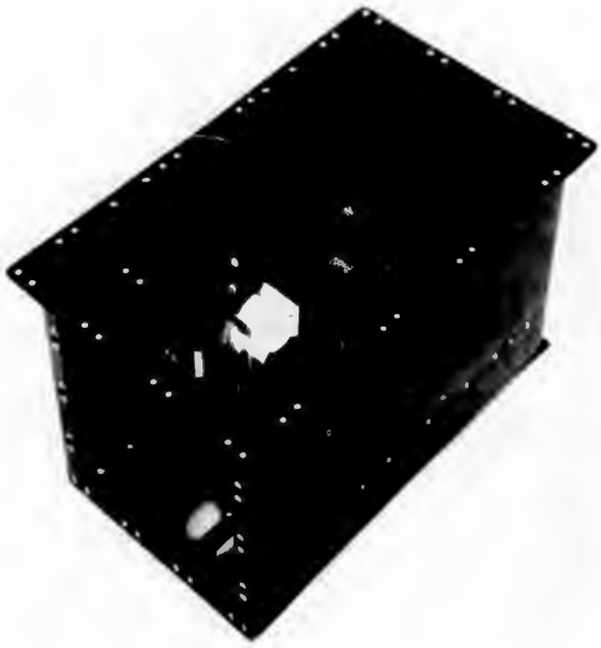
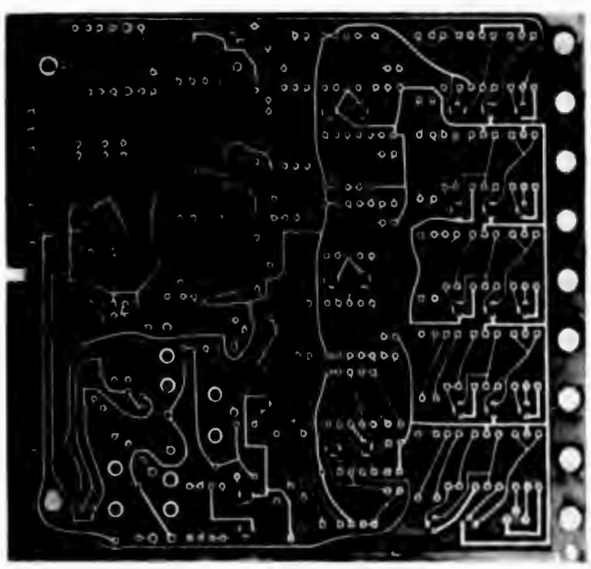


Figure 3. Electronics Unit Housing
(Photo 4R14292)



a) Solder Side
(Photo 4R14294)

b) Component Side
(Photo 4R14288)

Figure 4. Typical Circuit Card

function. For the worst conditions, the average value of cell resistance increased by 30 percent in 9 months, but maximum difference in resistance between samples was 12 percent. In the FRUSA application, this would result in an array pointing error of 2 degrees, compared to the 10 degrees permitted by the specification.

It is concluded that there should be no problem with use of these cells as planned on this program.

THERMAL ANALYSIS

Thermal analysis of the orientation subsystem was completed. The resulting thermal finishes specified comprise combinations of surface polish, vacuum-deposited aluminum, bonded aluminized Teflon, and white paint on the outside, and thermally black anodizing on interior surfaces. In addition, a thermal blanket is used to cover two sides and the base of the control electronics unit and each end of the drum axis housing. By this means, temperatures of all components are maintained well within the design range of -50 to +150°F, with differential temperatures across the bearings less than 25 degrees, for all orbit conditions.

ELECTRONICS UNIT

Fabrication and assembly of the qualification unit was started during this period; 163 of a total of 192 procurement line items have been received. These components have been placed in kits and are ready for assembly operations.

The unit housing has been completed except for some minor surface polishing operations. The circuit cards have been completed and assembly of the boards is currently in process. Completion will depend on delivery of the outstanding components. Photographs of some of the control electronics unit hardware are shown in Figures 3 to 6.

REACTION WHEEL DRIVE

The reaction wheel drive was specified, designed, and critical circuits tested during this period. The schematic diagram for the wheel command control electronics is shown in Figure 7, and for the wheel control electronics, in Figure 8. The drive is designed to operate a single Bendix Type 1880026 (Advanced Vela) reaction wheel to counteract torques generated in support axis steering of a 1.5 kw FRUSA whose angular rate is limited to 0.5 deg/sec. With minor modifications, the system is applicable to FRUSAs generating up to three times more angular momentum than the present baseline (i.e., the system can accommodate substantial changes in FRUSA dimensions, mass, or angular rate limit).

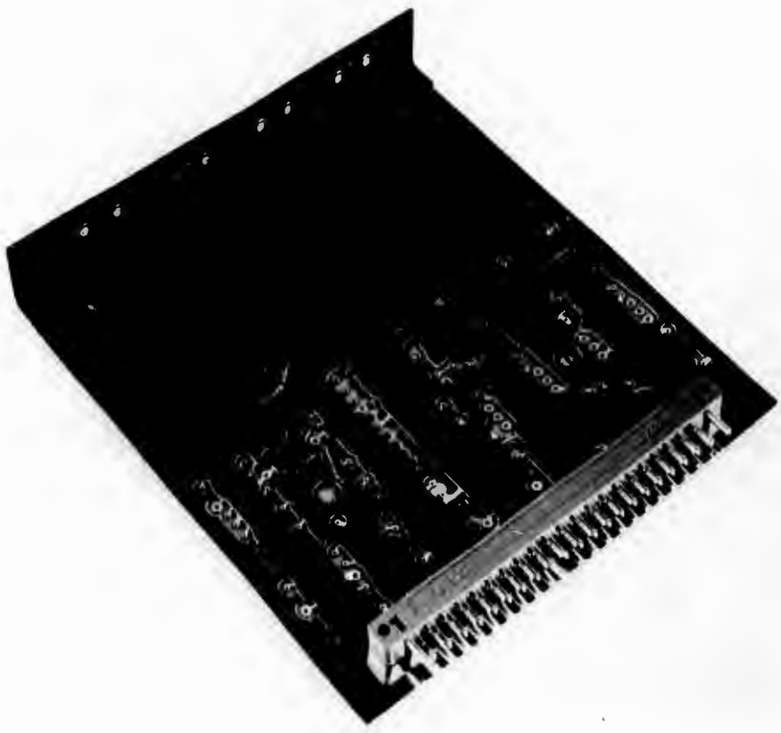


Figure 5. High-Power Circuit Card With Additional Heat Sink

(Photo 4R14296)

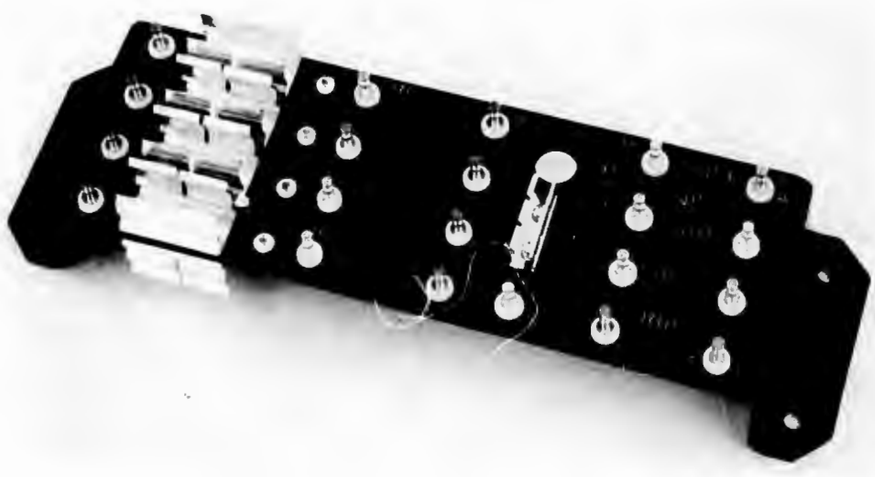


Figure 6. Component Bracket

(Photo 4R14287)

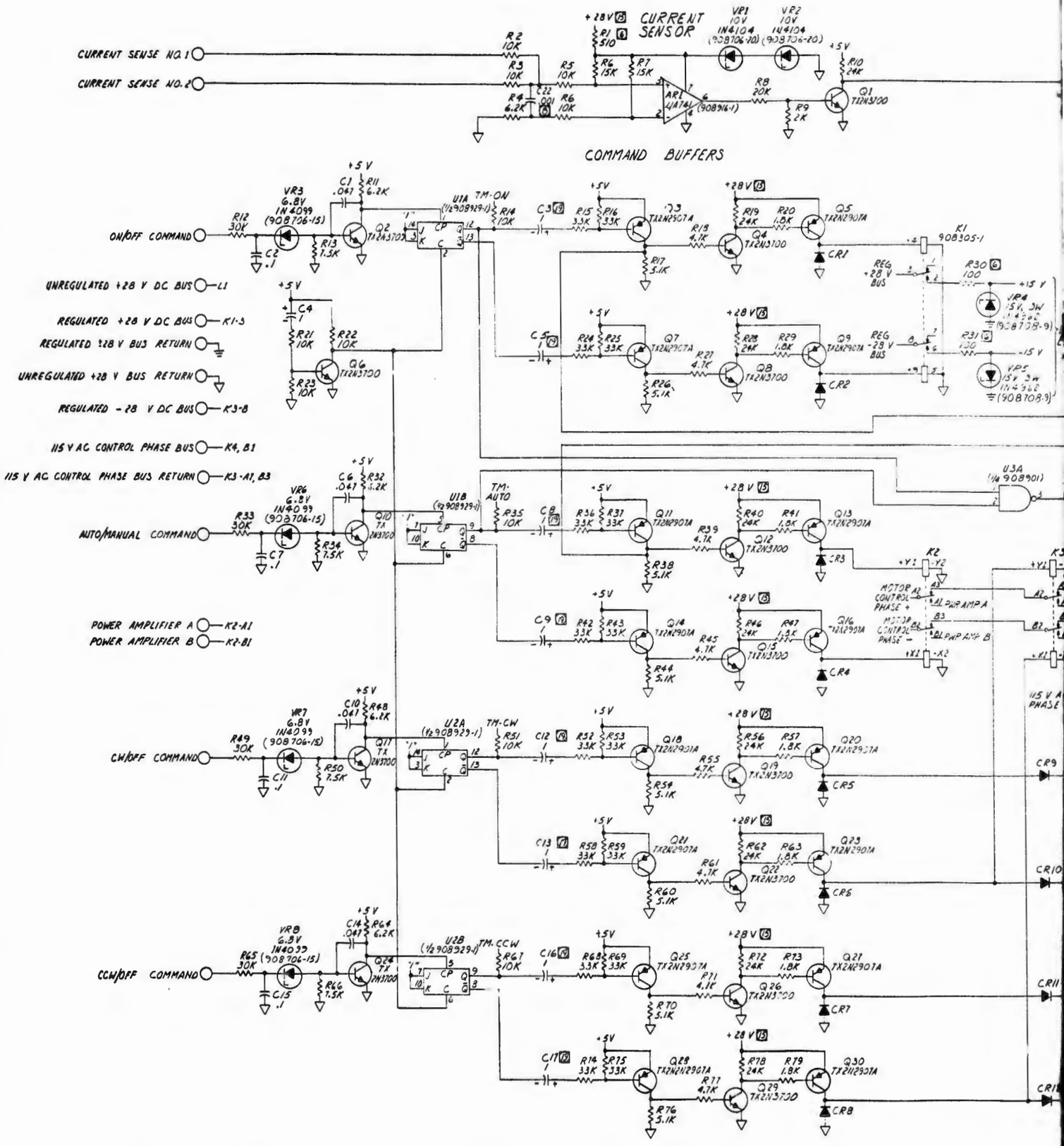
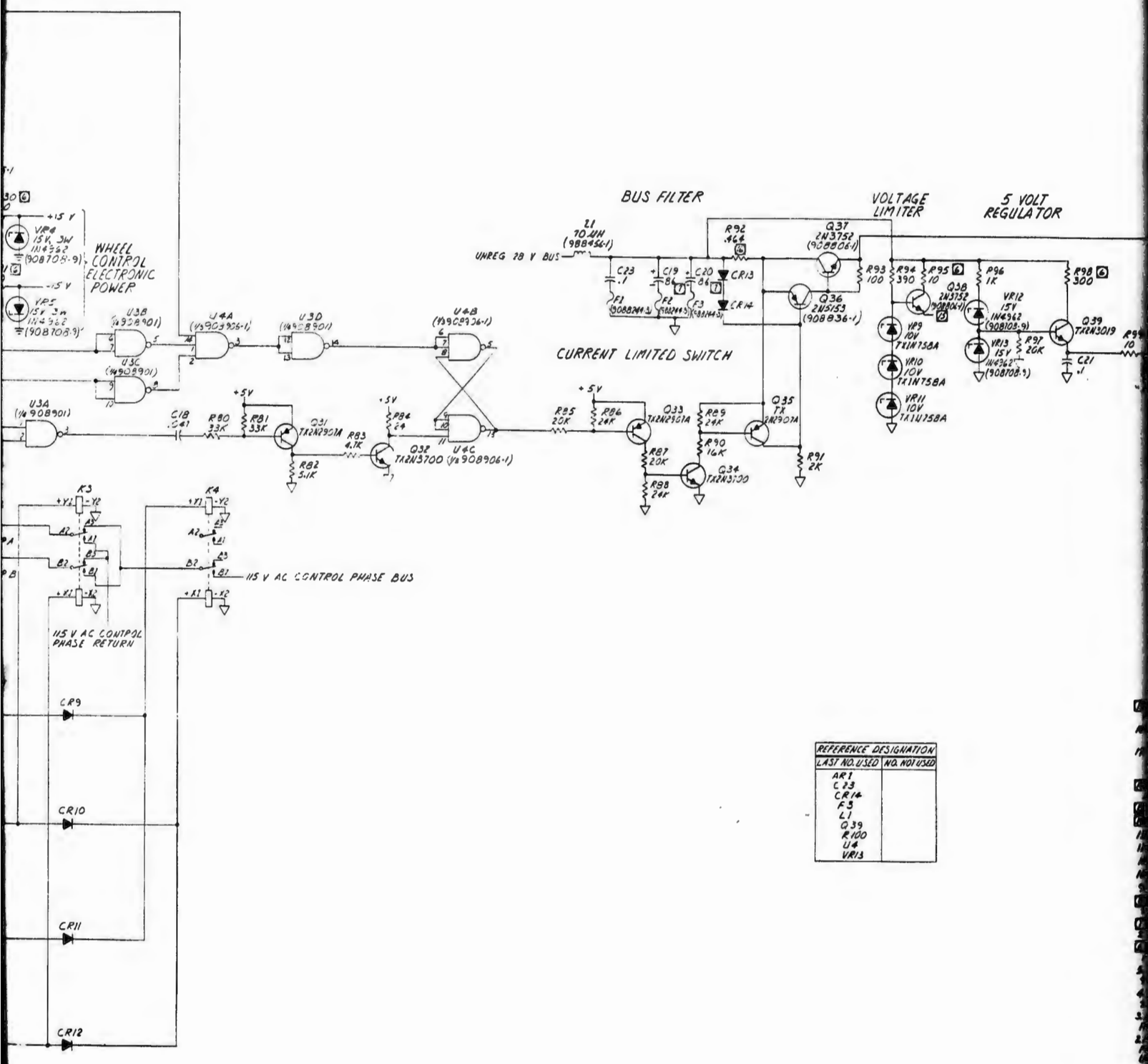


Figure 7. Wheel Command Control Electronics
(Drawing 3064413)

A



REFERENCE DESIGNATION	
LAST NO. USED	NO. NOT USED
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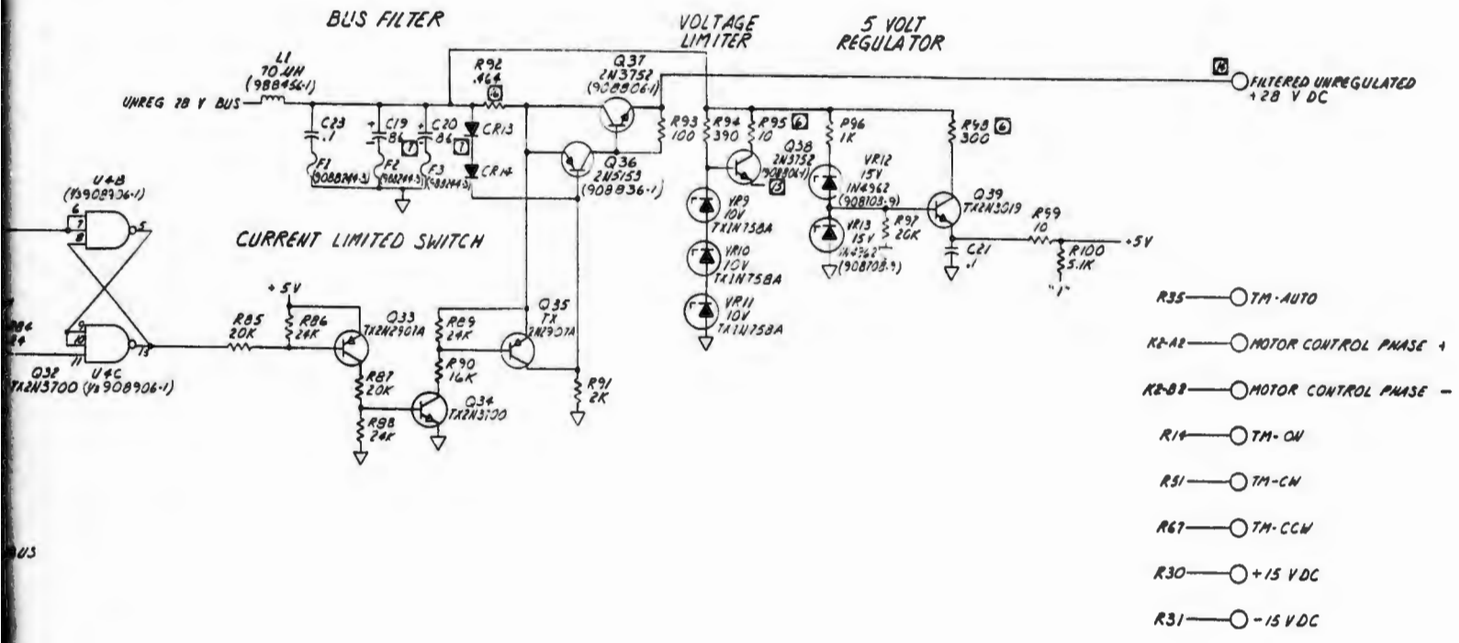
C23	
CR14	
F3	
L1	
Q39	
R100	
U4	
VR13	

B



REFERENCE DESIGNATION	
LAST NO. USED	NO. NOT USED
AR1	
C 23	
CR14	
F3	
L1	
Q39	
R100	
U4	
VR13	

(7) CAPACITANCE VALUES ARE IN MICROFARADS: ±10%, 50 V (CSR13G___KS)
18. PIN 4 OF ALL GATES AND FLIP-FLOPS ARE CONNECTED TO +5 V BUS
17. PIN 11 OF ALL GATES AND FLIP-FLOPS ARE CONNECTED TO UNREGULATED +28 V RETURN
(6) RESISTANCE VALUES ARE IN OHMS: ±1%, 1 W (908612-65)
(5) VOLTAGE LIMITED +28 V
(4) FILTERED UNREGULATED +28 V
13. ALL FLIP FLOPS ARE 908929-1
12. ALL 3 INPUT GATES ARE 908906-1
11. ALL 2 INPUT GATES ARE 908901-1
10. RELAYS ARE 983275-1
9. ALL DIODES ARE TYPE TAIN3070
(8) CAPACITANCE VALUES ARE IN MICROFARADS: ±10%, 200V (CKR05BX___KS)
(1) CAPACITANCE VALUES ARE IN MICROFARADS: ±20%, 100 V (988566-60)
(2) RESISTANCE VALUES ARE IN OHMS: ±5% 1 W (RCR32G___JS)
5. CAPACITANCE VALUES ARE IN MICROFARADS: ±10%, 100V (CKR06BX___KS)
4. RESISTANCE VALUES ARE IN OHMS: ±5%, ½ W (RCR07G___JS)
3. ALL 900000 SERIES NO. ARE VENDOR ITEMS - SEE SPEC CONTROL DWG
2. PARTIAL REF. DESIGNATIONS ARE SHOWN FOR COMPLETE DESIGNATION PREFIX WITH UNIT NO. OR SUB-ASSY DESIGNATION (3)
1. FOR ASSY SEE DWG
NOTES: UNLESS OTHERWISE SPECIFIED

C

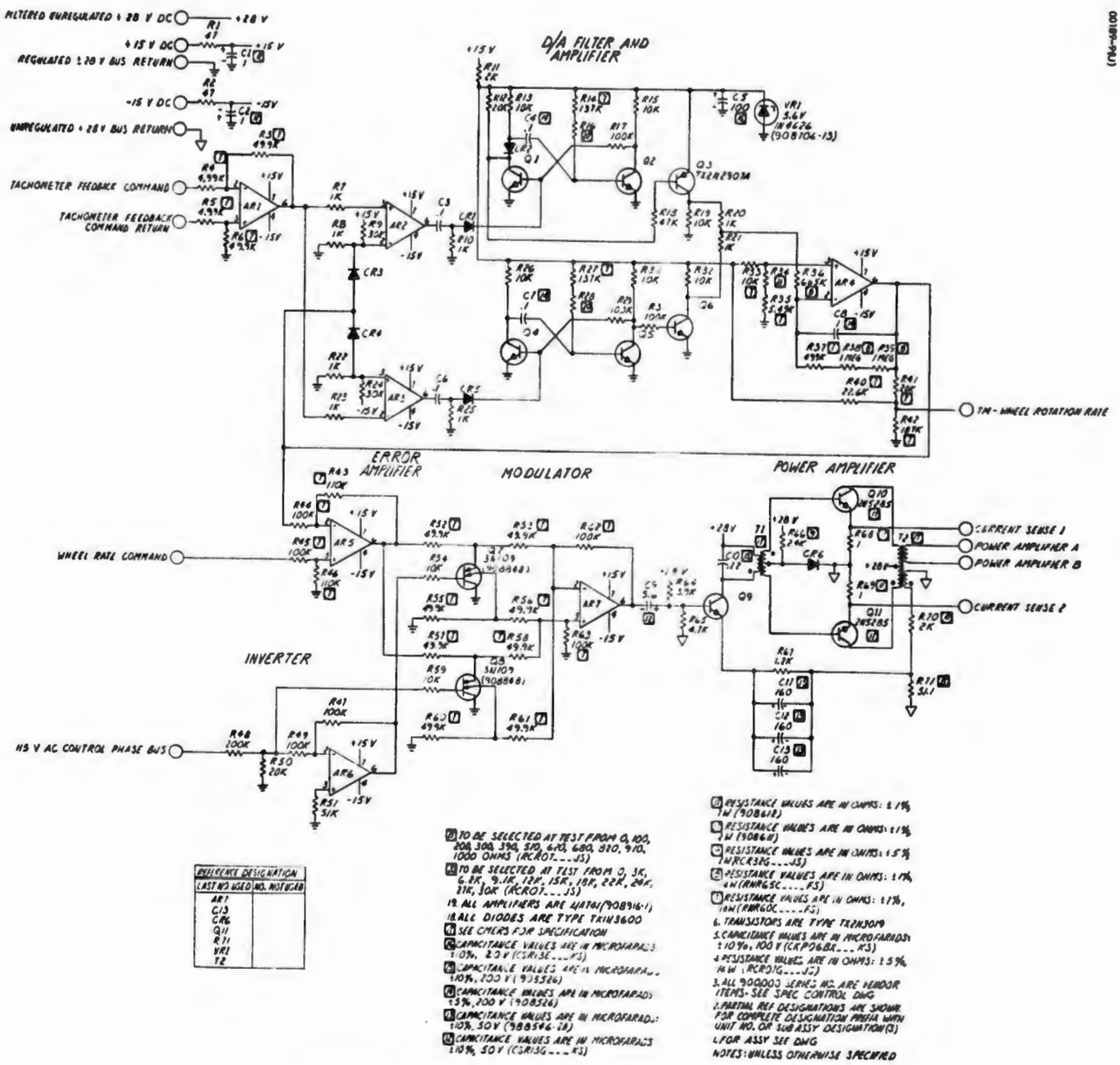


Figure 8. Wheel Control Electronics

(Drawing 3064414)

PLANS FOR NEXT QUARTER

Effort during the coming quarter will be devoted primarily to fabrication and assembly of the qualification unit. It is not planned to start testing until July. Substantial effort may also be required for liaison with the SESP 71-2 integrating contractor.

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SECTION VI

POWER SUBSYSTEM

POWER CONDITIONING UNIT PACKAGING DESIGN

The packaging concepts for the power conditioning unit have been finalized, and the drawing task is about 40 percent complete. The basic construction consists of a box with vertical separators between compartments. Heavier components such as transformers, inductors, and relays will be mounted on the bottom plate. Circuit cards, constructed with standoff terminals on metal plates, will be placed vertically along the sides of the box. The heat paths for the cards are through the metal plates to covers mounted on the outside for radiation heat transfer. EMI reduction is accomplished by bringing wires into one area of the box, using feedthrough capacitors or filters and employing EMI gaskets on the covers.

POWER SUBSYSTEM BREADBOARD TESTS

To further check individual circuit breadboard performance and to evaluate their ability to operate together, a complete power subsystem breadboard test program is being conducted. (The functional block diagram is shown in Figure 9.) The ambient temperature portion of this program has been completed. Some minor problems noted during these tests have been corrected and as soon as equipment becomes available, thermal tests will begin. The temperature range will be 20 percent below and 20 percent above the expected mission extremes. Additional data on the boom actuator motor 400 Hz inverter breadboard will be gathered during the engineering tests on the drum mechanism (see Section IV of this report).

BATTERY/CHARGE CONTROLLER

The configuration of the battery/charge controller package has been established. Each of the two units required will consist of a charge controller and two packs of 12 Ni-Cd battery cells each integrally mounted on one plate. The cells being employed are of a space qualified design with a 6 amp-hr capacity (Figures 10 and 11). Preparation of assembly drawings and modifications to existing drawings is currently in progress.

The procurement documentation for cell purchases has been prepared and will be released soon. In addition to procuring of qualification and flight model cells, a small number will be purchased for development test purposes.

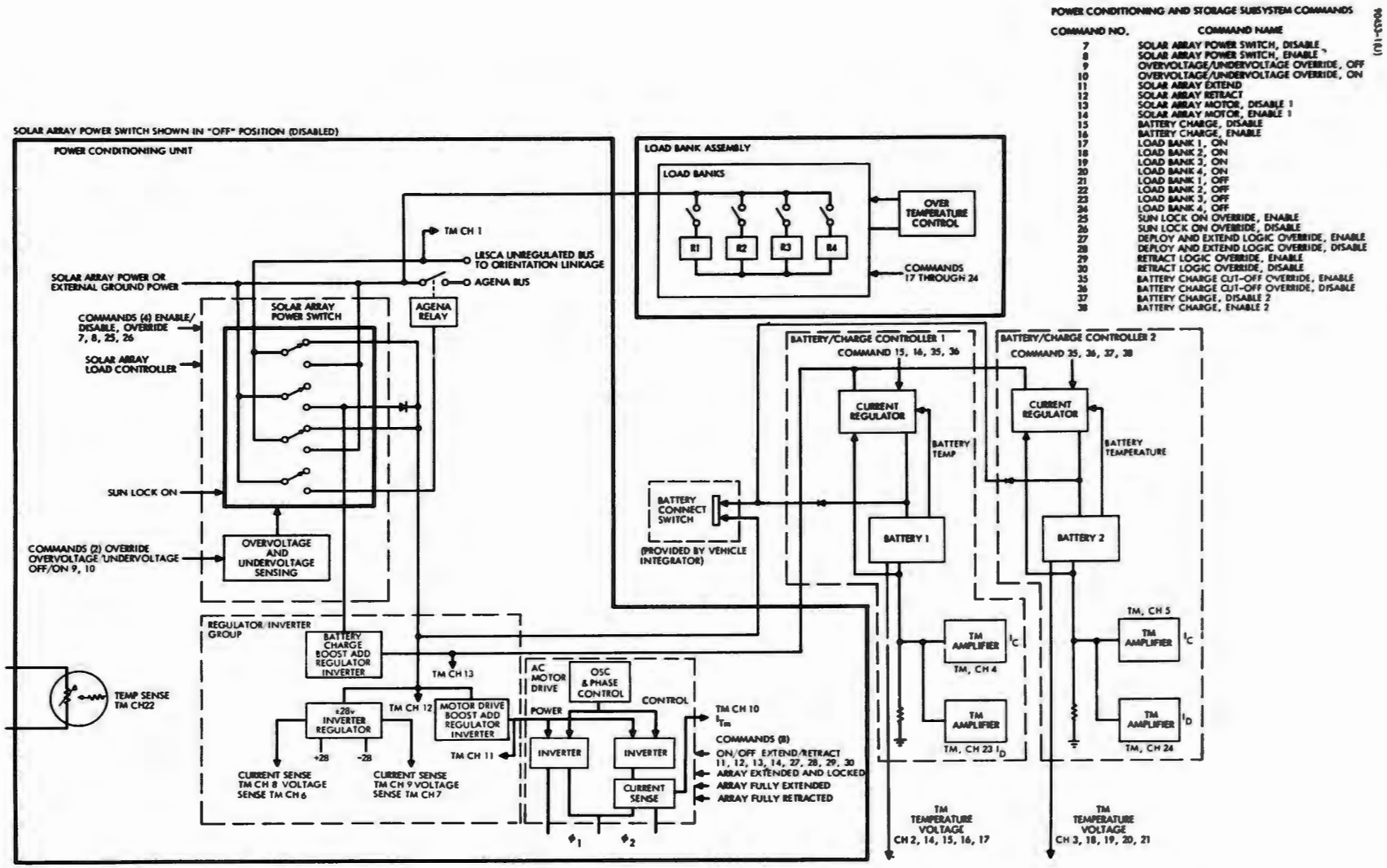

Figure 9. Power Conditioning and Storage Subsystem Functional Block Diagram

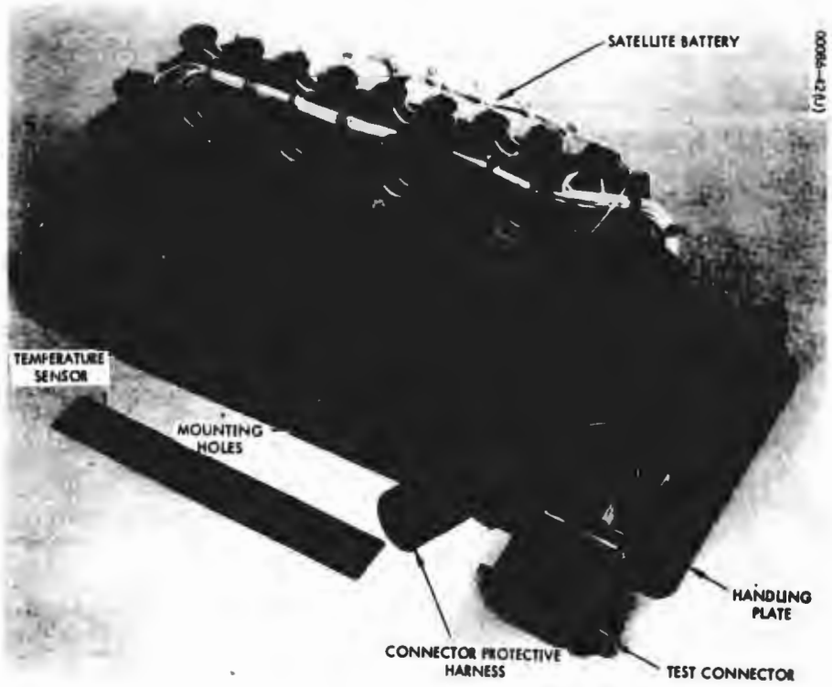

Figure 10. Space Qualified Battery
(Photo 00086-42)

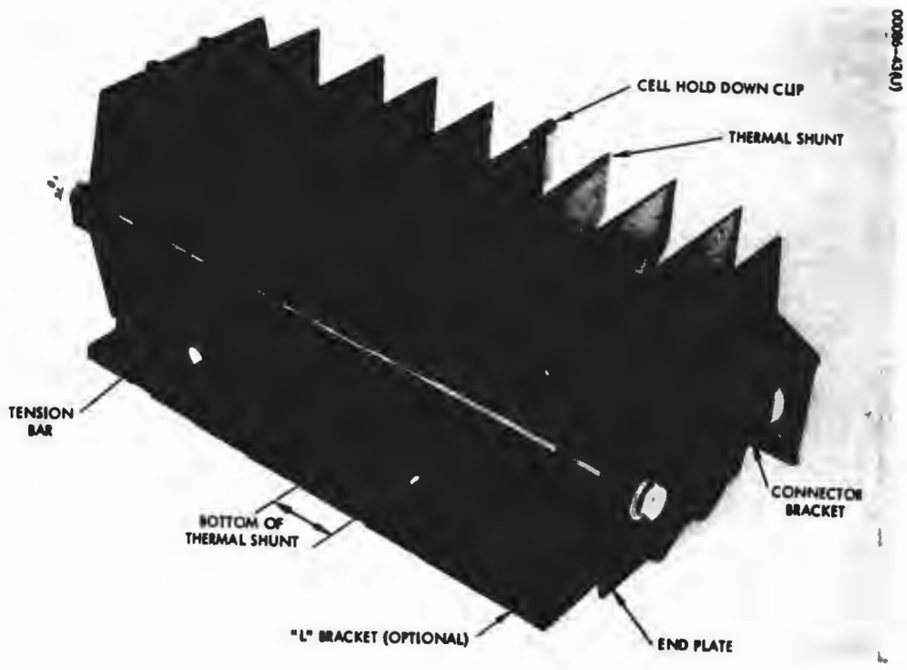

Figure 11. Battery Components
(Photo A24210)

PLANS FOR NEXT QUARTER

- Continue PCU packaging design effort
- Conduct power subsystem breadboard tests over anticipated orbital temperatures
- Continue work on assembly drawings for battery/charge controller
- Release battery cell procurement package

SECTION VII

INSTRUMENTATION SUBSYSTEM

ICU/SCEU

Fabrication, assembly, and test of the instrumentation conditioning unit (ICU) and the solar cell electronics unit (SCEU) was initiated during this report period. The status of this effort is as follows:

ICU

Procurement:	7 of 17 line items have been received.
Fabrication:	The unit housing and circuit board have been completed.
	The hardware is shown in Figure 12.
Assembly:	This work is currently under way. Completion is dependent on component deliveries.

SCEU

Procurement:	45 of 55 line items have been received.
Fabrication:	The unit housing shown in Figure 13 has been completed. Circuit boards are currently being fabricated.

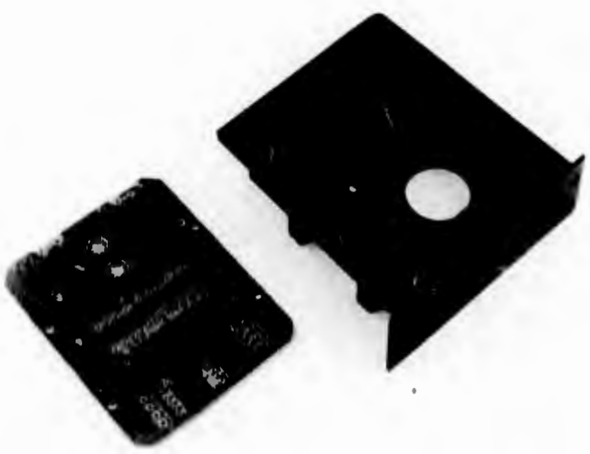

Figure 12. Instrumentation Conditioning Unit Housing and Circuit Card

(Photo 4R14293)

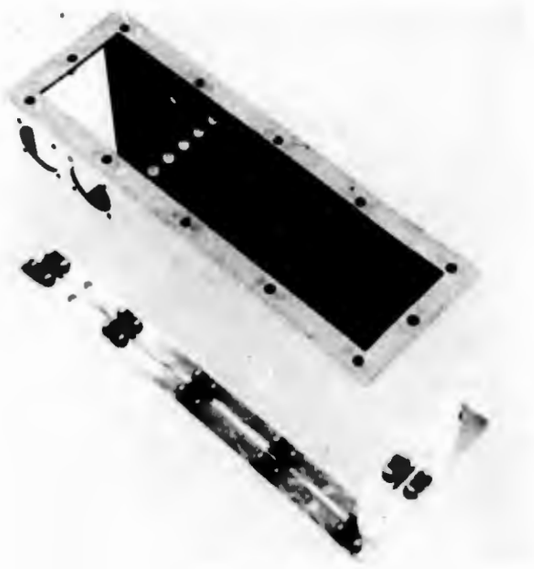

Figure 13. Solar Cell Electronics Unit Housing

(Photo 4R14291)

ACTIVITIES FOR NEXT PERIOD

1) Continuation of fabrication

2) Interface discussion with integrating contractor to ensure compatibility of the Agena and the FRUSA instrumentation system.

SECTION VIII

SYSTEM TEST

The systems test effort and progress during this reporting period consisted of the following:

1) Additional water table humidity tests

2) Completion of vibration fixture conceptual design

3) Fabrication of systems test fixture

4) Upgrade of the preliminary system test qualification plan

5) Redesign of overhead camera installation

The upgrade of the systems test plan was continued. The interim final version is scheduled for publication during the month of April.

A rerun of the water table humidity test was completed during this report period. A Honeywell Model 612X21-KL-74 continuous recording temperature and humidity instrument was utilized for the test. A water level of 1.5 inches was established on the tables and the humidity sensor was installed 0.75 inch above the water line and 2.0 feet from the table edge. The recording was initiated at 0800 hours 28 January 1970 and concluded at 0800 hours 10 February 1970 (see Figure 14). During this recording period, the building air conditioning and dehumidifying equipment was shut down from 2300 hours to 0500 hours each day. This shutdown was necessitated by problems with the conditioning equipment. This shutdown, of course, aggravated the humidity conditions. Under these adverse conditions, however, the maximum humidity measured was approximately 52 percent. Additional measurements will be made when the conditioning equipment can be operated continuously.

The drawings for the systems test fixture were transmitted to the Hughes Culver City model shop for fabrication. The fixture was designed to be fabricated from wood, thereby reducing the cost of materials and labor. Fabrication will be completed the first week of April. The early fabrication of this fixture was initiated so that it would be available for subsystem assembly and test, eliminating the need for additional holding fixtures.

The redesign of the overhead girder/camera installation has been completed and the drawings are presently in check and coordination by the Hughes facilities personnel. This redesign was necessitated by the possibility of unacceptable support vibration from air conditioning equipment and the adjacent jet aircraft operations at the Los Angeles International Airport.

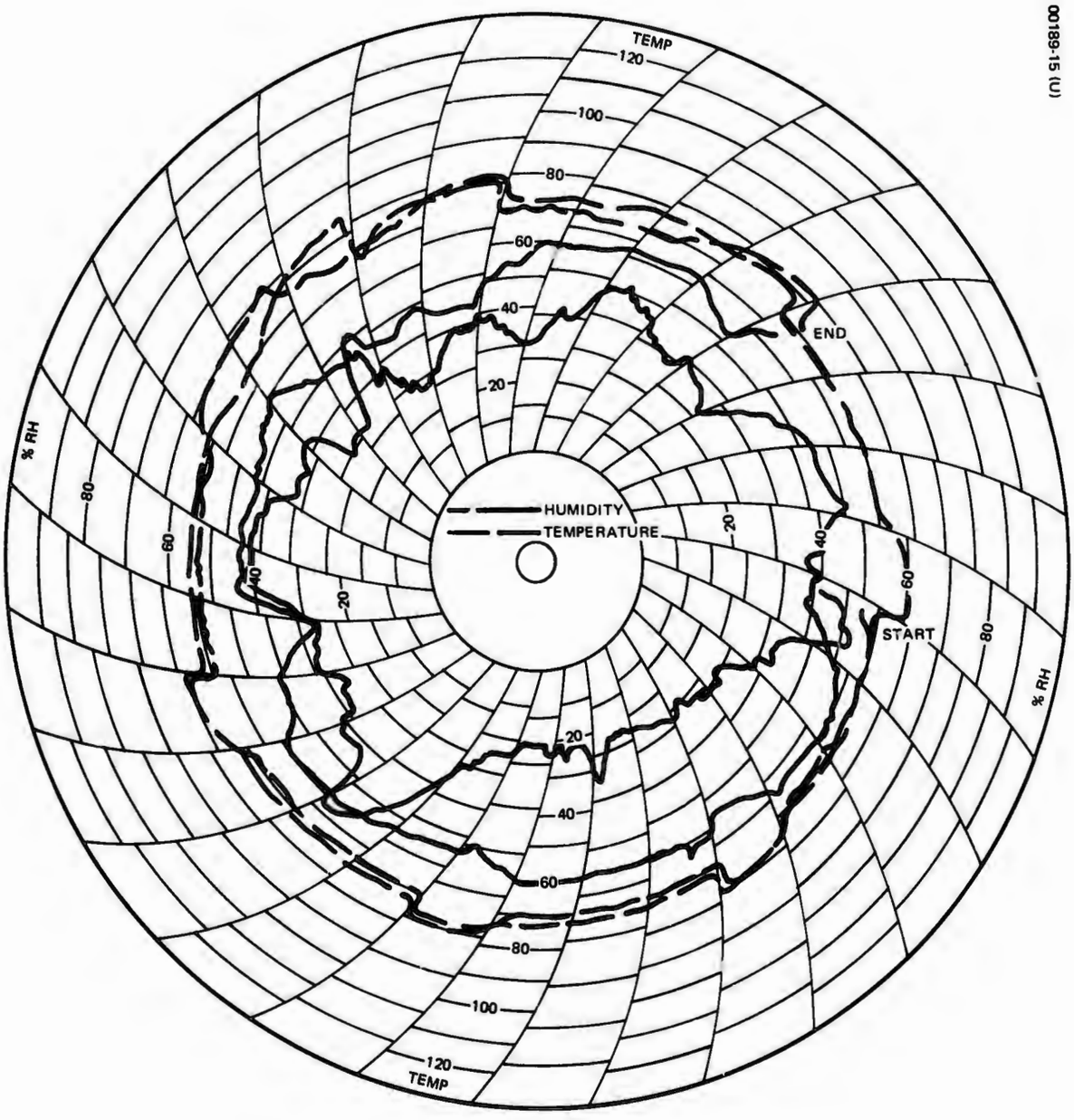

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Figure 14. Water Table Humidity Test Results

Conceptual designs of the vibration fixtures for the solar array, orientation mechanism, and power subsystem have been completed and verified by computer analysis. The fixture for the solar array, by far the most complex, showed a frequency coupling at approximately 1000 Hz where a lateral axis bending mode (third bending mode for that axis) was roughly the same as a possible torsional mode or higher order cross-axis response. This mode, however, was not considered significant.

The effort on the fixtures was suspended due to fiscal funding considerations. It is expected that the effort will be reinitiated the latter part of May 1970.

PLANS FOR NEXT QUARTER

1) Deliver and check out systems test fixture

2) Complete upgrade of systems test plan

SECTION IX

RELIABILITY

A revision of the Quality Plan has been published. One of the changes in the plan is that all hi-rel parts (instead of a sample) will receive incoming inspection. Traceability of these hi-rel electronic parts will be by lot number. Another change makes it clear that equipment logs will be started at the unit level and continued through the subsystem and system test.

The preferred parts list has been revised to include several more electronic parts. This list now contains well over 100 different electronic items.

As most assembly and all testing is done in environmentally controlled rooms, personnel having access to those rooms have been indoctrinated with the necessary procedures and precautions. Lists of approved personnel have been prepared.

The first preliminary system maintainability analysis, HS-207-204(12), has been completed. The system MTTR meets the design goal of 32.00 hours. Of note is the complete domination of the touch repair time by the administrative and logistic times. This occurs as a result of the assumption that only minor repair would be attempted at the launch facility or the integration contractor's facility. Accordingly, the FRUSA MTTR could be reduced by as much as 75 percent, if necessary, by providing a spares capability (such as upgraded qualification units) at the launch and integration facilities.

During the quarter an estimate of the system reliability was made and found to meet the requirement of 0.65 for 1 year.

WORK TO BE PERFORMED

1) Source surveillance of high reliability to parts, to assure that they conform to the high reliability part specification

2) Incoming inspection of parts

3) Inspection of qualification model parts

4) Fabrication inspection

5) Initiate TFR system

6) Initiate equipment logs

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13. ABSTRACT

The main activities on the Flexible Rolled-Up Solar Array (FRUSA) program during the seventh quarterly reporting period consisted of drawing release of all the FRUSA subsystem components, with the exception of the power electronics and storage, and startup of manufacturing of the development/qualification model. The solar cells required for the qualification model have been received and wired into the required cell groups ready for bonding, together with the blanks, to the solar panel. The storage drum is in the final stage of fabrication, and the small and large housings for the orientation mechanism are ready for final processing prior to start of assembly.

The design of the reaction wheel drive and a verification test of the critical circuits of the drive, which provide an analog of wheel rate from pulse-type rate pickoff data, have been successfully completed. A complete power subsystem breadboard test program was started during the reporting period. The changes requested by the customer to make the FRUSA telemetry system compatible with the Agena PCM system, to increase the deployment arm length and decrease the orientation mechanism slew rate, have been implemented in the design.

The Performance, Design and Product Confirmation Requirements Specification (DS 30992-001) reflecting all necessary modification as of 15 March 1970 has been released. The FRUSA Interface Requirements document has been upgraded and a revision of the Quality Plan published.

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